file PTI Annual Report

# Third Annual Report of the Public Technology National Aeronautics and Space Administration Technology Application Program 1973-74


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PUBLIC TECHNOLOGY, INC. is a non-profit, tax-exempt, public interest organization established in December 1971 as an institutional mechanism for applying available technologies to the problems of state and local governments. Sources of such technologies include federal agencies, private industries, universities, and state and local jurisdictions themselves. PTI works in both the hardware and software fields.

PTI works on specific problems that have been defined and given a high priority by state and local government officials. A problem also must be common to many units of government throughout the nation, and one that is susceptible to technological solution. In this way two major organizational goals are realized: (1) costs and benefits of large-scale undertakings are shared; and (2) private sector, federal agency, and foundation investment in the solution of public sector problems is encouraged by the aggregation of specific markets at the state and local levels of government.

The technology application process consists of these steps: problem definition; location of applicable technology; development of new or improved products or systems; appropriate packaging of the technology for state and local governments; and help in adapting and implementing the technology at the operating level. Emphasis is placed on transfer and subsequent utilization of the technology by the largest possible number of jurisdictions. On-site assistance is provided, upon request, to make certain that state and local jurisdictions fully utilize the technolog

PTI was organized, and is governed, by the executive officers of the Council of State Governments, International City Management Association, National Association of Counties, National Governors' Conference, National League of Cities, and U.S. Conference of Mayors.

# *Third Annual Report of the Public Technology National Aeronautics and Space Administration Technology Application Program 1973-74*

**ACKNOWLEDGMENTS** Public Technology Inc., expresses its appreciation for the support of the many individuals and organizations participating in the Public Technology, Inc. and National Aeronautics and Space Administration Technology Application Program, which was jointly supported by NASA under contract NASW-2530 and subscribing jurisdictions of Public Technology, Inc.

NASA program officers Anthony H. Breard and William L. Smith, and Jeffrey T. Hamilton, Director of the NASA Technology Utilization Office have provided valuable guidance to the program. The technical consultations with various NASA centers are greatly appreciated. The following NASA technical personnel directly participated in the Program projects: James V. Correale, Maurice A. Carson, and Pat B. McLaughlan at the Johnson Space Center; Leonard L. Kleinberg at the Goddard Space Flight Center; Dr. Judd Wilkins at the Langley Research Center.

The jurisdictions participating in the program have provided valuable staff time to respond to numerous inquiries. Particular thanks go to the members of the User Requirements Committees for their extensive participation, valuable advice, and enthusiastic support. These people are listed in the Appendix.

The Program Director at Public Technology is Joseph M. Carlson. Program personnel include Roger M. Rowe, Warren D. Siemens, G. Wade Miller, and J. Tom Smith. The support and advice of Porter W. Homer, President of Public Technology Inc., and Senior Vice President Ronald J. Philips have been invaluable to all phases of the program.

## *Executive Summary*

The NASA/PTI Technology Application Program started in the fall of 1970. Since then the program has been in continuous operation through a series of contract awards to Public Technology from the NASA Technology Utilization Office. This third Annual Report covers a thirteen month performance period from August, 1973 to mid-September, 1974. The impetus for creating this program was a growing concern among public administrators regarding the relatively slow rate of technological innovation in the goods and services used by cities, counties and states. The NASA/PTI Technology Application Program addresses this concern, and has the goal of applying NASA technology to specific needs identified by state and local government officials.

The Introduction and Background section briefly describes the history of the program and its early accomplishments. Subsequent sections describe the activities of individual projects. Currently the program includes three equipment development projects:

- Firefighter's Breathing System
- Firefighter's Short-Range Communications Equipment
- Improved Coliform Detector for Water Quality Monitoring

All three projects have gone through the process of identifying a high priority problem of state and local governments, defining user requirements and finding a NASA technology applicable to the problem. However, each is at a different stage in the cycle of new product development and commercial introduction.

The Firefighter's Breathing System (FBS) project is the oldest of the three projects described in this report. During this reporting period Public Technology, under contract to NASA Headquarters, provided a user perspective regarding performance parameters of the system and kept the user community aware of the project status. The NASA Johnson Space Center, utilizing its crew equipment and life support design expertise, developed prototype systems with a private contractor. Concurrently, the PTI project staff conducted market research, which revealed the market shares of current equipment and the potential demand for the NASA system. The FBS project is now entering Federal certification testing and an in-depth field test and evaluation phase.

The Firefighter's Short-Range Communications Equipment project concentrated on the development of engineering prototypes of low cost short-range voice communications equipment. The purpose of this development was to determine the technical and economic feasibility of utilizing a patented NASA technology in this particular application. In a follow-on phase PTI under NASA support will contract with a private manufacturer to design and build 25 field test models for evaluation in several municipal fire departments.

The Coliform Detector project was a new project initiated during the report period. In the initial phase Public Technology convened a User Requirements Committee, whose members are prominent in local government water quality monitoring and sewage treatment operations The Committee reviewed NASA plans for developing an improved coliform detector. (The presence of coliform bacteria in water is a principal indicator of fecal contamination). The Committee foresaw a very promising market for the NASA device. NASA is currently developing this detector at the Langley Research Center.

## *Introduction and Background*

The NASA/PTI Technology Application Program started in 1970 when eighty jurisdictions agreed to join NASA, the International City Management Association, and Public Technology, Inc. in the application of aerospace technology to specific needs of local governments. In the fall of that year representatives of these jurisdictions met with NASA and PTI personnel in a three-day conference at the Kennedy Space Center in Florida. Here these representatives were briefed on specific NASA technologies, learned techniques for identifying problems with technology content, and studied ways of defining such problems at appropriate levels of detail.

By early 1971 PTI had received nearly 500 problem statements for review and prioritization. A newly formed National Coordinating Committee, representing the eighty jurisdictions, selected forty-three problems most common to a majority of the participants. NASA's Technology Utilization Office and PTI reviewed these, and chose fifteen problems to which aerospace technologies and capabilities could make the greatest contribution. PTI then prepared expanded problem statements and background information for these fifteen. During the early part of 1971 representatives of the eighty jurisdictions met at three regional meetings to review and rank the top fifteen problems. These are listed in the accompanying table.

**FIFTEEN PRIORITIZED PROBLEMS**
Submitted to PTI by Eighty Jurisdictions

1 Self-Contained Breathing Apparatus for Firemen
2 Short-Range Communication Systems
3 Pavement Marking
4 Protective Clothing for Firemen
5 Underground Pipe and Conduit Locator
6 Automatic Fire Hose Flow Regulator
7 Command Control Center Design
8 Body Armor for Policemen
9 Toxic and Flammable Waste Disposal
10 Electrical Fault Detection
11 Portable Traffic Counter
12 New Fire Hose Materials and Couplings
13 Emergency Patient-Monitoring
14 High Voltage Power Transmission
15 Non-Emergency Patient-Monitoring

SOURCE: *Technology for the Cities,* First Annual Report of the NASA/PTI Technology Application Program, 1971.

By mid 1971 PTI had begun to organize and convene individual User Requirements Committees for several of the top six priority problems. Committee membership included municipal administrators, finance officers, purchasing agents, labor representatives, and municipal department heads familiar with the scope and nature of the problems. These committees provided a means for city participation in all phases of the program. PTI and NASA spent the remainder of 1971 conducting literature searches, investigating possible aerospace technologies, and formulating early design concepts for solving some of the problems.

NASA awarded a second contract to PTI at the beginning of 1972 to continue this program. At that time, development phases were started on two of the top priority projects, the Firefighter's Breathing System

(FBS) and Firefighter's Protective Clothing. In addition, a commercial product survey was done for Firefighter's Short-Range Communications equipment. By the end of 1972 the design and construction phases were going on for the Breathing System and Protective Clothing.

Because solutions for three of the six top priority problems were well into development by the start of 1973, NASA and PTI took steps to add new projects to the Technology Application Program. One step was to determine if NASA technology could favorably impact on the Firefighter's Short-Range Communications problem. PTI discussions with NASA field centers led to the discovery of a patented NASA electronic circuit technology, whose application in radio circuit design could bring about low cost, high performance equipment. Another concurrent step was the initiation of a new problem identification and screening process. PTI staff reviewed the original five hundred problems and others submitted by PTI subscribing jurisdictions over the intervening years. From this process emerged the need to monitor the quality of potable water in the supply systems of local jurisdictions. To be specific, there was a need to determine the presence of coliform bacteria, a standard indicator of fecal contamination. Concurrent with this need identification, PTI canvassed the NASA field centers to see if any relevant NASA technology existed for solving the problem. From this search PTI determined that a potential solution was being developed at the NASA Langley Research Center.

In August 1973 the NASA Technology Utilization Office awarded PTI a third contract to continue the NASA/PTI Technology Application Program. The activities performed under this third contract provide the subject matter of this Annual Report. During this contract performance period the program activities have been concentrated in three projects:

- Firefighter's Breathing System
- Firefighter's Short-Range Communications Equipment
- Improved Coliform Detector for Water Quality Monitoring

A separate section of this Annual Report is devoted to each of these three projects and their accomplishments. While the following sections elaborate on these, some are worth noting here: PTI worked closely with NASA in promoting an awareness in the nation's fire service of the NASA developed, improved breathing apparatus, and conducted market research on the demand for such equipment. The program staff also investigated the nature of the short-range communications equipment market. The design and construction of engineering prototypes of improved short-range communications equipment was accomplished utilizing a patented NASA electronic circuit design technology. A User Requirements Committee, consisting of prominent persons in water quality and treatment, was established and convened. General and specific requirements in water quality monitoring as related to the NASA coliform detector and other NASA water quality monitoring programs were researched.

Through the NASA/PTI Technology Application Program, NASA and PTI are playing vital roles in solving specific, frequently mentioned municipal problems with defined applications of aerospace technology. Moreover, the encouraging responses of PTI subscribing jurisdictions to this particular program indicate that local governments view it as being extremely important for improving their own operations.

## *Firefighter's Breathing System*

The 80 jurisdictions participating in the 1970 PTI/NASA conference ranked the need to improve the firefighter's breathing apparatus first among all the problem areas needing attention.

Firefighting is the most hazardous occupation in the United States.[1] In a single year one third of the active firefighters in the nation will suffer some injury. Eighty percent of these injuries are caused by the inhalation of smoke, toxic gases, or by the exposure of firefighters to oxygen deficient atmospheres.[2] This rate of injury occurs even though firefighters are furnished with breathing apparatus.

The problems inherent in current breathing apparatus have discouraged their widespread use by fire suppression personnel. Often, firefighters prefer the risk of smoke and toxic fumes to the bother and discomfort of donning protective breathing apparatus. Among the problems which tend to discourage use of breathing apparatus are:

- Excess weight
- Bulky profile
- Short duration
- Uncomfortable to wear
- Difficult to put on and take off

Under a NASA contract PTI assembled a User Requirements Committee (URC) to give advice and guidance to NASA in the effort to develop an improved breathing system. The Committee was comprised of fire chiefs, fire training officers, personnel specialists, and city administrators. (See Appendix for URC membership listing.) The problem, as defined to NASA by the PTI User Requirements Committee, was to design a system that would remedy all these shortcomings of present systems but which would still be available at a price and in a form acceptable to the nation's fire service. Following a commercial product survey the User Requirements Committee agreed with NASA engineers that while some chemical systems may be smaller or lighter, an improved demand-type compressed air system is the optimum moderate duration system for widespread fire service use. The User Requirements Committee agreed that the inherent safety and reliability of compressed air systems far outweigh any weight or duration disadvantages. They further believed that the familiarity which the fire service has with compressed air systems would aid in the broad adoption of an advanced system.

Under the guidance of the URC, development of the NASA FBS was carried forward. Hardware developmental contracts were let by Johnson Space Center for:

- The design of an improved lightweight pressure vessel
- An improved harness, regulator, mask system
- Adaptation to higher pressure compressed air charging stations for fire service use

Pressure vessels of aluminum, overwrapped with fiberglass, were developed in both 40 standard cubic feet for moderate duration use, and 60 standard cubic feet for extended duration as recommended by

*The NASA Firefighter's Breathing System has improved design features incorporated in the face mask, harness, pressure tank and regulators.*

[1] *America Burning*, the report of the U.S. National Commission on Fire Prevention and Control.

[2] *Breathing Apparatus for the Fire Service.* NFPA publication. August, 1971. Page 1.

the URC. The two pressure vessels are interchangeable in the harness system. A contract for development of the 60 standard cubic foot vessel was awarded to Structural Composites Industries, Inc. A second contract for the 40 standard cubic foot vessel went to Martin Marietta Corporation. The pressure vessel design, utilizing NASA high pressure vessel technology, offers the advantages over steel bottles of being lightweight, utilizing higher pressures safely, and being corrosion-resistant for reduced maintenance.

The pressure vessel has been granted special permit approval by the Department of Transportation. The complete system is currently under testing for certification by the National Institute for Occupational Safety and Health.

The harness, regulator, and mask system was designed to incorporate much of the knowledge gained in space crew equipment activities, including human factors engineering. The resulting unit is designed so that the system weight is carried by the hips rather than the shoulders. This gives better balance to the wearer and reduces fatique. A bubble-type face piece is used to increase the firefighter's vision. A dual-path primary pressure regulator is mounted on the harness pack frame. This location was chosen because it does not interfere with firefighting operations and does not increase the profile of the unit. The mask-mounted demand regulator contains a depletion warning device and may be detached quickly from the mask. The mask was designed to eliminate interference with the firefighter's helmet. The contract for prototype development of the NASA breathing system was awarded to Scott Aviation.

Under NASA contract, the American Instrument Company has built a high-pressure intensifier for existing charging stations and has developed specifications for 5000 psi charging systems. The high-pressure intensifier will allow a fire department currently equipped with a 2400 psi charging station to modify its system without a complete replacement of charging equipment.

Under the current contract, PTI conducted an extensive market research effort for the Firefighter's Breathing System. The research involved discussions with over 60 fire departments throughout the country. Fifteen manufacturers of equipment and over 50 distributors were contacted in the collection of data.

The purpose of this survey was to identify the size characteristics of the market for use in formulating plans to commercialize the FBS. The survey attempted to determine the number, type, frequency of use, and replacement rate of firefighters' breathing apparatus. The survey identified the major competitors, their market shares, and estimated price elasticity of the market. The market research again highlighted the importance of lighter weight and extended duration in the fire service market.

An additional mail survey was made of the fire service community to introduce selected fire departments to the current status and capabilities of the NASA FBS and gauge the possible market place response to the commercial introduction of the new high pressure system. This survey attempted to discover how many jurisdictions had 5000 psi charging capability and what their initial purchase rate of the NASA system might be. The survey revealed the following four points about the FBS market:

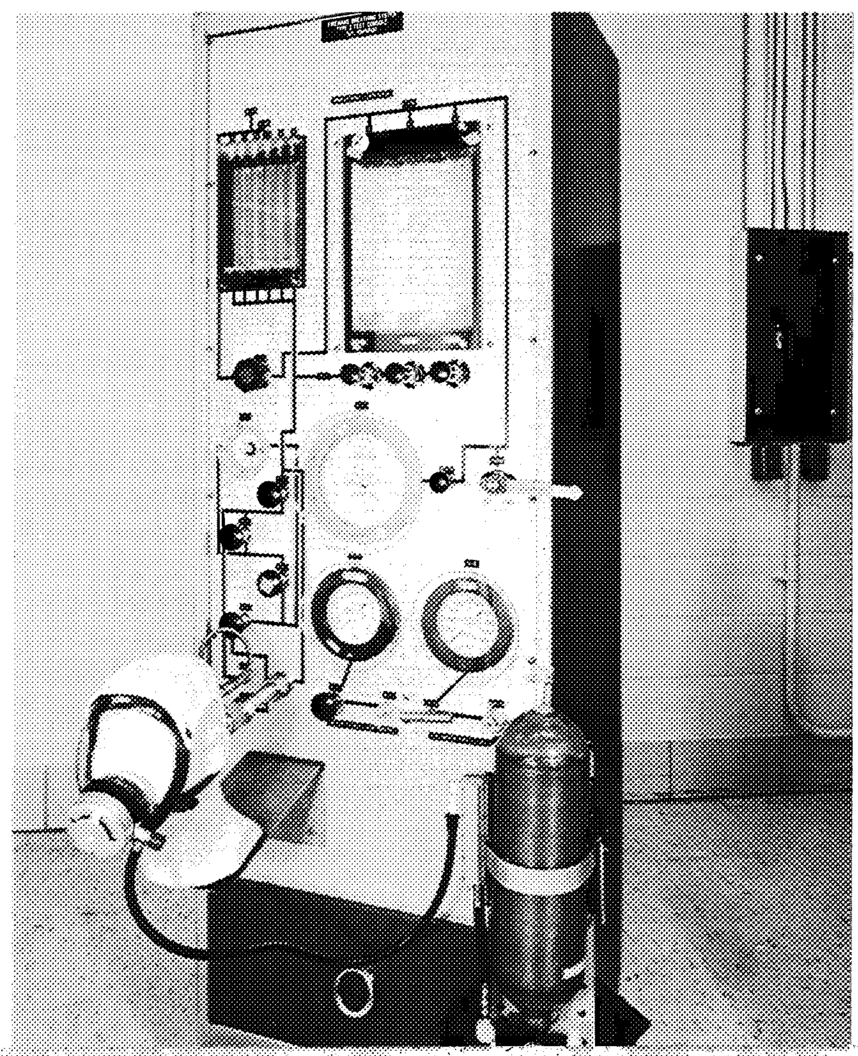
- There is a substantial segment of the market which already has, or is acquiring, 5000 psi charging capability

- Large cities are upgrading their charging capabilities faster than smaller ones
- Pent-up demand exists for improved breathing apparatus
- Worst case projections show the NASA system could capture 20% of the market in its first year of production

A program is under way to acquaint the fire service community with the merits of the NASA FBS system. This is being done through PTI and NASA attendance at fire service meetings and by distributing technical brochures and reports on the system to muncipalities. Fire service comment on the system has been almost universally favorable.

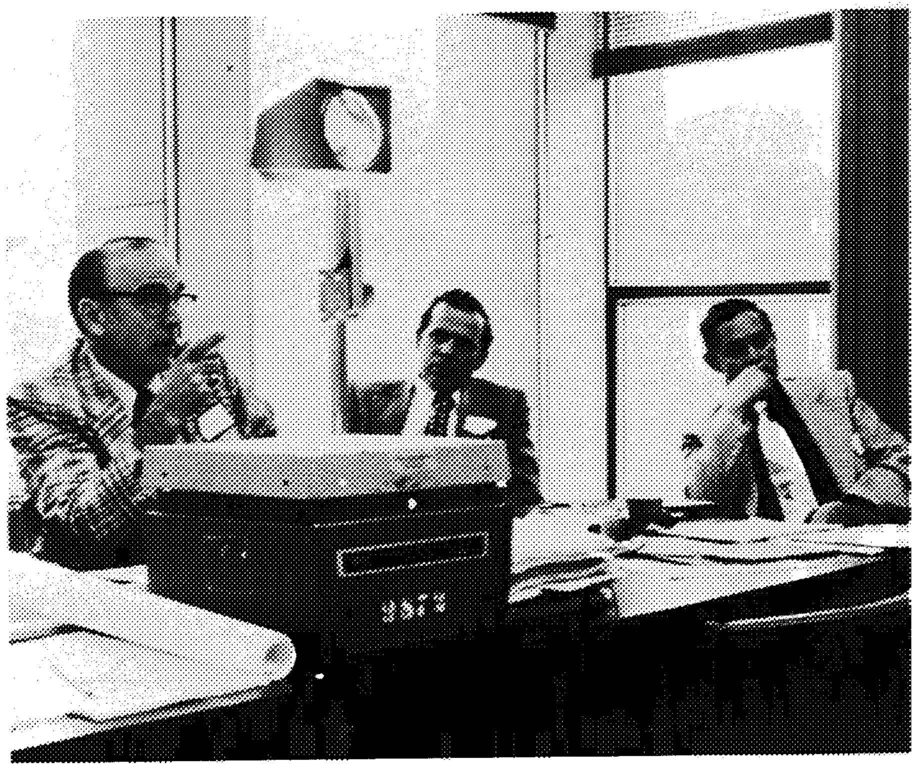
A field evaluation program is now under way to test the NASA FBS in actual fire service use. Three large metropolitan areas have been chosen for the test sites: Houston, Los Angeles, and New York City. Test site field support for routine maintenance and data collection has been arranged. The system will be operationally evaluated by first line fire suppression personnel and a record of unit performance will be maintained. The gathering and reporting of actual field service data is an important element in gaining widespread fire service acceptance for the unit. Field service data will be collected, analyzed and widely disseminated by PTI and NASA.

PTI will prepare an awareness package for this product to be distributed to local jurisdictions who procure FBS equipment. This document will set forth the performance specifications of the NASA FBS and give a cost justification and procurement rationale for local governments to use in acquiring the system.



*Utilizing several test stands for the NASA FBS, Johnson Space Center engineers have thoroughly evaluated the system performance under varying conditions.*

*The PTI User Requirements Committee for the NASA-sponsored Firefighter's Short-Range Communications Project evaluated two-way radio designs utilizing the NASA inductorless circuit technology.*



## *Firefighter's Short-Range Communications Equipment*

Local governments submitted to Public Technology a high priority need for short-range communications equipment for use at the scene of a fire. The Introduction of this Annual Report has pointed out that this need was ranked second among the top fifteen priority problems identified at the beginning of the NASA/PTI Technology Application Program. Discussions with fire service representatives since then indicate that this need is still important.

Fire departments employ two-way portable radios at the fire ground for command and control of firefighting operations. Firefighters are deployed throughout the fire ground either in small teams or individually to accomplish various tasks: apply water; ventilate the burning structure; rescue victims; investigate the general situation. Timing and coordination of these individuals is paramount for effective, safe firefighting. However, the hostile environment, high ambient noise levels and restricted visibility hinder or preclude normal voice communications. The situation is even more complicated when the burning structure is a high-rise building with firefighters situated on different floors of the building. Thus, the need emerges for reliable, convenient, short-range voice communications equipment.

The devices currently used for fireground communications are hand-held, portable two-way radios. However, this equipment has several drawbacks. A major one is high cost. The prices of the most popular portable radio brands range from $750 to $1,300 depending upon operating frequency and performance features. While portable transceivers priced as low as $350 are available, these units have less performance capability, and are often less durable. This high unit price, coupled with the limited fire budgets found in cities throughout the country, limits their distribution to chief officers and selected company officers.

Other drawbacks of the available products include size, weight and configuration. The commonly accepted units are rectangular in shape, and are carried either in turnout coat pockets or on leather belts or straps. Voice transmission is accomplished by either holding the unit to the mouth or by using a remotely connected microphone.

Maintainability is another concern. The electronic components in current models are packed closely together. This makes repair and maintenance a time-consuming, difficult job. In many cases only expert radio technicians can work on the radios with any degree of success.

In 1973 Public Technology established a User Requirements Committee to advise PTI and NASA on the development of a solution to the problem. Committee members included fire chiefs, fire department communications supervisors, budget officers and city managers from large and small cities throughout the country (See Appendix). At an initial meeting in June the Committee defined some general performance requirements for improved short-range communications equipment. These are listed in Exhibit 1. The Committee established the following order of importance for these constraints: low cost; high performance; small size and low weight; configuration and ease of operation; resistance to a harsh environment and rough handling.

Concurrent with defining user requirements, PTI contacted NASA field centers to determine the availability of suitable NASA technologies. Discussions with the Technology Utilization Office and technical personnel at the Goddard Space Flight Center uncovered a patented NASA technology, described as an inductorless electronic circuit design ("Active Tuned Circuit", patent number 3,693,105). This unconventional circuit design approach replaces inductances and coils in radio frequency (RF) circuits with combinations of low cost transistors, resistors, and capacitors. This substitution produces several benefits:

- Reduces circuit size since high-quality RF inductances occupy 10% to 50% of circuit package
- Improves electrical performance by making tuned circuits with quality factors three to five times better than conventional, inductance designs
- Reduces cost of circuits by allowing use of cheap discrete components or integrated circuits and by reducing manufacturing labor
- Improves durability by allowing smaller package design, which in turn makes equipment more compatible with firefighter's other equipment
- Improves maintainability by making integrated circuit, modular construction more feasible

Because these benefits coincide with the needs of the fire service, NASA and PTI decided to pursue the development of improved equipment utilizing this design technique.

Under the current phase of the NASA/PTI Technology Application Program the project staff initiated such a development program. The project objectives were to experimentally determine the technical and economic feasibility of the NASA inductorless technology, and to work toward rapid commercialization of the technology, based on the results of these feasibility experiments. One project task was to develop engineering prototype models of short-range portable transceivers, utilizing the NASA technology. Two of these were designed to operate in the VHF (150-170 MHz) public safety radio band, and the other two in the

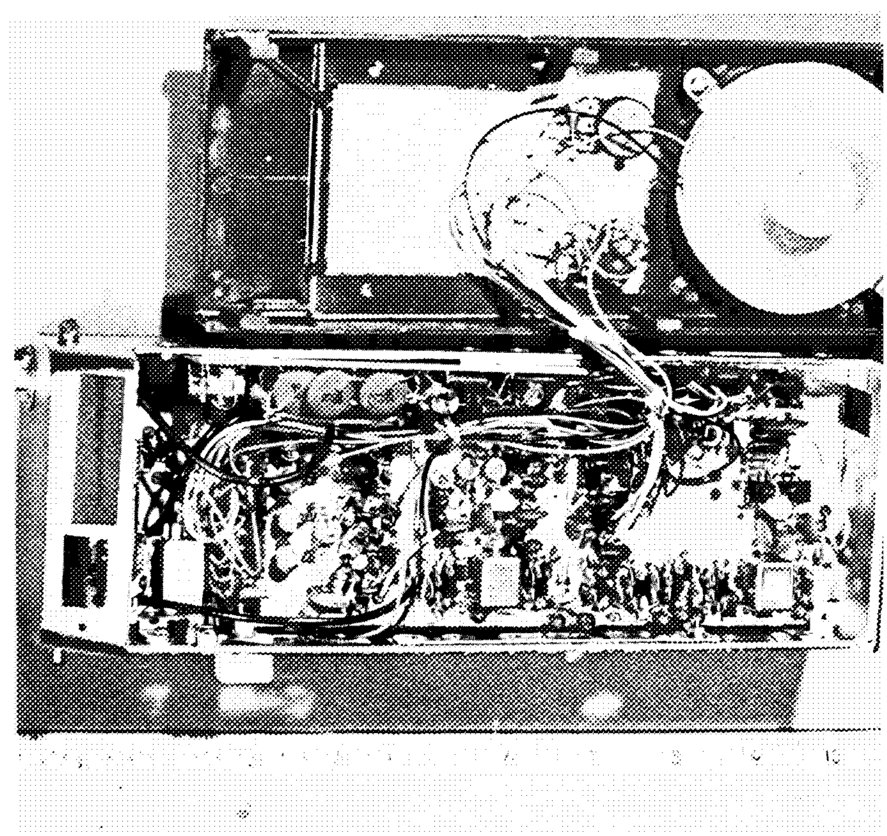
UHF (450-470 MHz) band. The latter could be modified to cover the optional frequency band of 450-512 MHz. To accomplish this task PTI conducted a formal procurement and issued a request for proposal to twenty-two prospective bidders in private industry. In February 1974 PTI awarded a subcontract for this development effort. The subcontractor has worked closely with NASA to apply the inductorless circuit techniques in several previous NASA communications projects.

In May 1974 the User Requirements Committee met to review the electronic designs of the engineering prototype transceivers. The Committee observed electronic tests of breadboarded inductorless RF circuits to be used in these prototypes, re-examined the equipment performance specifications and provided guidance on the shape, size and internal construction of these units. The URC members reviewed the overall project performance, and gave it their strong endorsement.

A second project task has been the collection and analysis of market data regarding such portable radio equipment. Through PTI's close contacts with local governments, the project staff obtained information on the market size, the current market shares of leading manufacturers, and the potential demand for an improved, low cost transceiver. This information will be used in selecting an appropriate company to commercialize the developed radios. Further, PTI believes market characteristics and demand information will stimulate a private firm to make the necessary commitment of technical, financial and marketing resources to bring about the desired objective of commercialization.

In August the User Requirements Committee again met with PTI to examine two completed engineering prototypes which incorporated the NASA technology. Laboratory tests indicate that these units have electronic performance comparable to that of the best commercial

*The engineering model of the NASA-PTI fire-fighter's short-range radio uses NASA technology to substantially reduce equipment cost with no performance sacrifice. Future field test models will be almost half the volume of this prototype.*



equipment available. Furthermore, the preliminary cost estimates for these units show that a lower priced radio can be built. Because of the favorable consensus regarding the prototype performance and low cost, the Committee went on to identify general requirements and constraints for a future field test program. The group also reviewed the market data previously collected by PTI and discussed procurement practices in local governments.

In the coming year Public Technology, under contract to NASA, will arrange to build 25 field test units, incorporating the electronic design evaluated in the engineering prototypes. These units will be tested under actual firefighting conditions in several of the municipal fire departments represented on the URC. Concurrently, PTI will carry out the commercialization aspects of the project. Licensing arrangements will be pursued in accordance with NASA patent licensing policy, which provides for exclusive licensing in appropriate cases.

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**EXHIBIT 1** **CONSTRAINTS FOR FIRE SERVICE SHORT-RANGE COMMUNICATIONS DEVICE**

1 Device should have a purchase price below $300, and if possible, less than $200.

2 Device should provide intelligible, two-way voice communication links between all functional groups and officers at the fireground.

3 Device must comply with all Federal regulations and appropriate standards for such equipment. Operation of the device on one channel should not interfere with operation of another similar device on a different channel at the same fireground.

4 The device should have the capability of transmitting messages through structures of masonry, brick, or steel-beam-reinforced concrete, particularly in high-rise buildings in an urban environment. The device should have a range of 1,500 feet in such an environment.

5 With emphasis first on performance, the device should be lightweight and small enough to be completely enclosed in firemen's protective clothing, excluding the helmet. Accessories should be available to allow operation of the device while wearing gloves, face mask and while handling other equipment. These accessories may be mounted in the helmet. Some form of manual operation should be required to operate the voice transmitter.

6 The device must operate under extremely hostile conditions found at the fire ground:

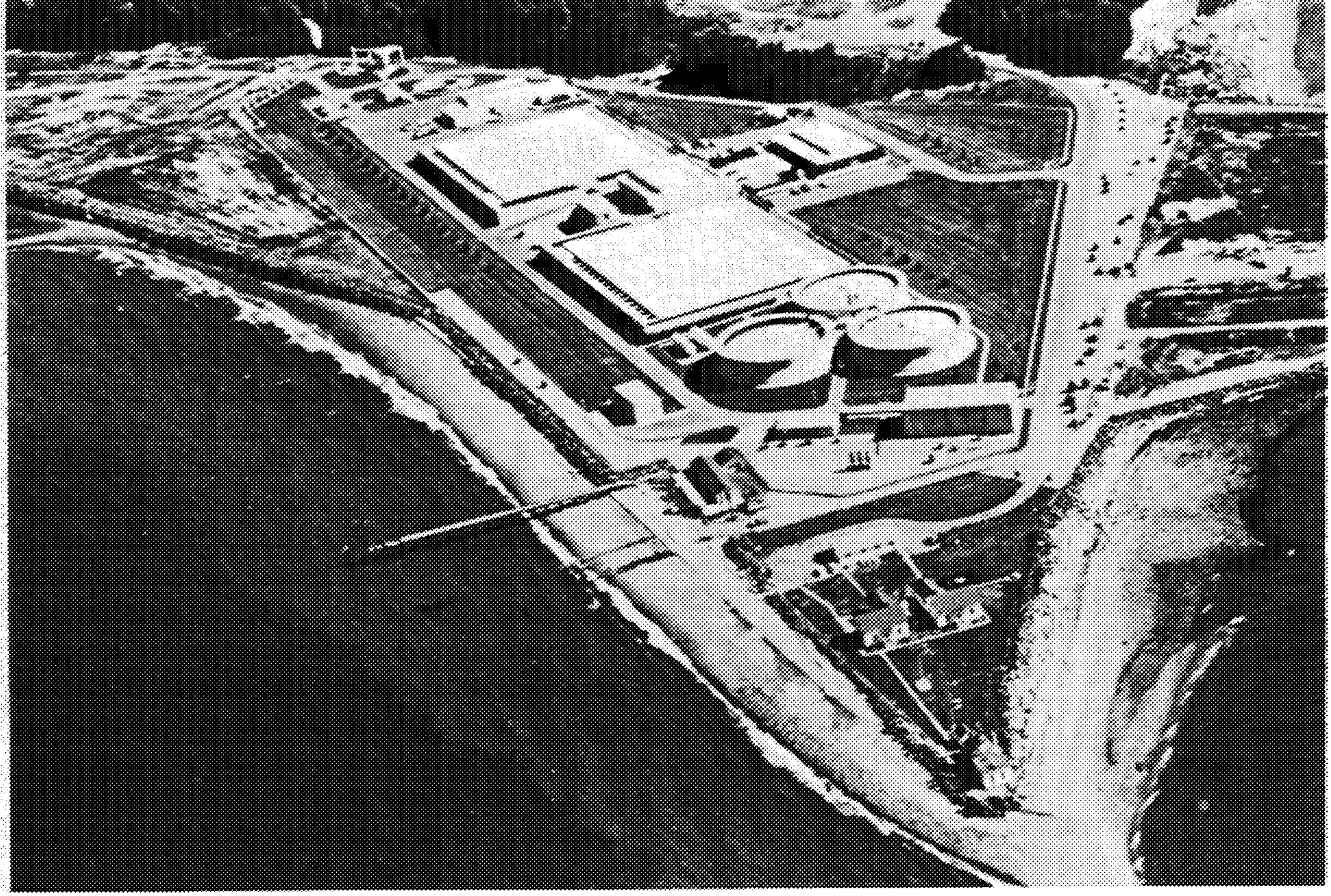
   a. High ambient noise level, 100 dbA maximum.
   b. Wide temperature range between −20°F and 160°F. (This assumes the device is adequately protected by its location on the user, and its housing.)
   c. Relative humidity 99% and spray.
   d. Smoke.
   e. Shock and vibration.

7 Device should be highly resistant to rough handling.

8 Device should have low failure rate, and be constructed for simple, quick repair and maintenance.

9 The device should be capable of operation from either rechargeable or non-rechargeable batteries. When in use, the power supply should allow the following minimum duty cycle: (transmit, receive, standby) 5/5/90; the design goal should be 10/10/80.

SOURCE: Internal PTI memorandum containing notes on meeting of User Requirements Committee held on June 25, 1973.



*Local government wastewater treatment operations will benefit from the NASA-PTI Water Quality Monitoring Program.*

## Improved Coliform Detector for Water Quality Monitoring

One of the high priority problems identified in the 1970-71 PTI problen search was the need for a new, improved device for the rapid detection of coliform organisms. When the original problem list was rescreened in 1973, the decision was made to examine the feasibility of developin such a device. This problem statement was then distributed to various NASA field centers in an attempt to match the problem with NASA technology. This process resulted in a response from NASA's Langley Research Center on an improved coliform detector. PTI staff met with a NASA/Langley research microbiologist who was in the process of developing the methodology and hardware for this device. It was decided that the NASA technology could be applied to state and local government water quality programs.

The need for a detection device for rapid determination of coliform organisms is well defined and documented. The coliform group of bacteria has been accepted as the principal indicator of the potabilit of water for domestic use. State public health agencies set standards and maintain laboratories to monitor water quality statewide and to certify county, municipal, or private laboratories and their methods. Municipal water works must constantly monitor water quality, a task requiring establishment of their own labs or proximity to privately owned labs. Private users are constantly in need of water quality measurements on privately owned facilities such as wells and swimming pools. One of the main problems in monitoring water quality is that the bacteriological analysis of water has failed to advance technologically at the same rate as physical and chemical analysis techniques and equipment. While it is relatively easy to detect the presence of bacteria in water, it is extremely difficult to determine which, among the many thousands of species of bacteria, are harmless and which are harmful to human health. It is known, however, that the presence of any type of coliform organism in a water sample indicates either inadequate treatment or dangerous infiltration into the distribution system.

The need for improved coliform detection techniques results from the fact that too much time is presently required to be assured that no coliforms exist in the water sample. The two major methodologies currently being used to detect coliform organisms are difficult to perform, time-consuming, and relatively inaccurate. One of these, the multiple-tube fermentation method, requires much time for sample preparation and 24-48 hours to determine whether or not the organisms are present. Determination of the most-probable-number (MPN) with 95% confidence requires an additional 24-48 hours. The second methodology is the membrane filter technique. Although this process is more rapid and simpler than the first, accurate results are unattainable unless the turbidity in the sample is extremely low. Since almost all wastewater effluents contain suspended material, this method is usually confined to use in potable water determinations.

The original NASA technology used in the development of the coliform detector employed a sensitive pressure transducer to detect the pressure buildup created by the gas production of microorganisms. A linear relationship was established between inoculum size and the elapsed time before rapid pressure buildup. This methodology could be used to detect the presence of gas producing organisms within a 12-hour period. In an extension of this original research, it was noted that by sensing molecular hydrogen, the detection sensitivity was markedly increased over the pressure transducer method. Further investigation has resulted in a methodology that can detect coliform organisms in six hours or less. In this newer method, the evolution of hydrogen gas is measured automatically and accurately using a combination noble metal-saturated calomel electrode system. Therefore, this coliform detector represents a substantial improvement over current state-of-the-art procedures for detecting the presence of coliform organisms in an aqueous sample.

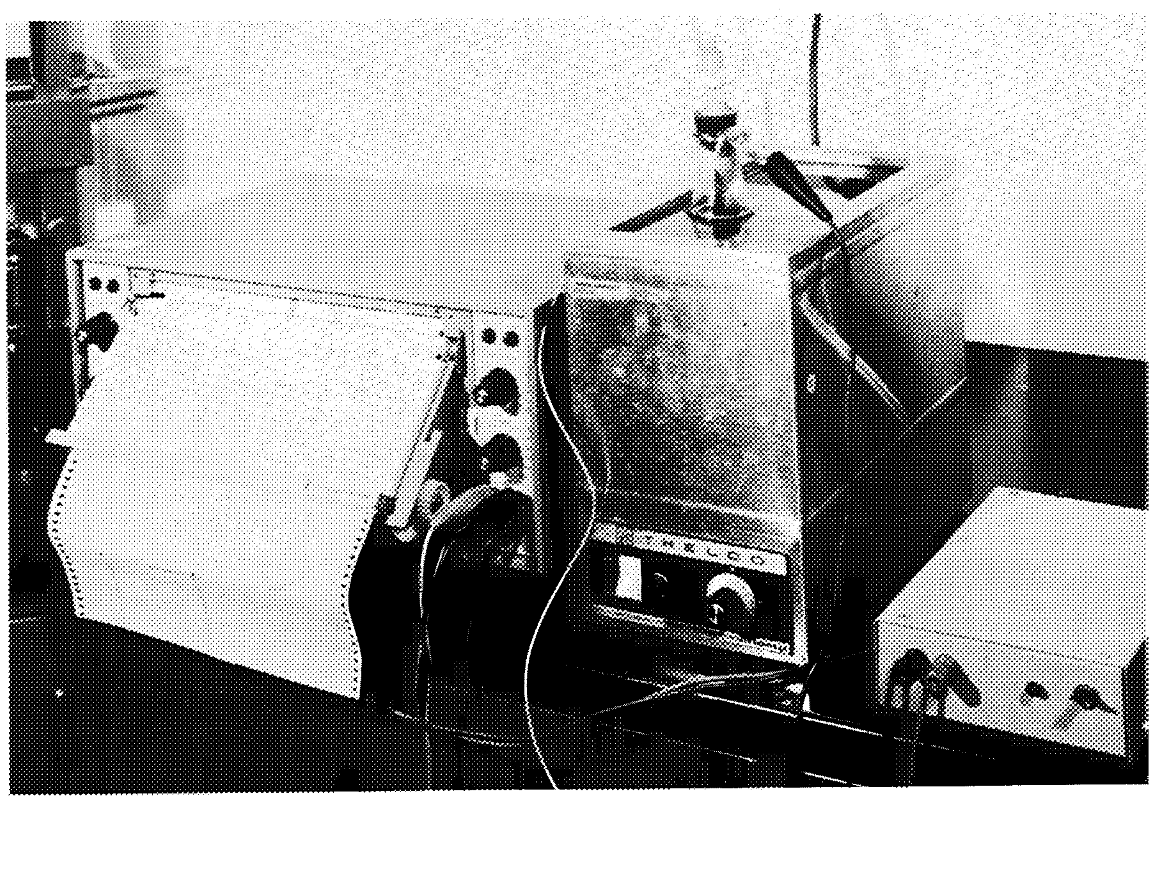
In order to ensure that the potential coliform detector would meet with the approval of the user community, PTI, under contract to NASA, organized a Water-Wastewater Management URC in 1973 (see Appendix ). Representatives on this Committee included key officials of professional water organizations, prominent members of the academic community, and Federal officials from regulatory agencies in addition to state and local government officials. The first meeting of this Committee took place in February 1974. This meeting had several purposes. The most general purpose was to familiarize the Committee with NASA organization, capabilities, and technologies related to the field of water quality. Second, a presentation was made on the coliform detector; comments concerning the concept and feasibility of such an approach were solicited from the Committee. A third purpose was to obtain inputs from the Committee on key water quality parameters, currently available instrumentation for measurement of those parameters, and inadequacies of such instrumentation. This information acquisition on water quality instrumentation was the first step in an approach to defining overall water quality monitoring needs, defining relevant NASA research, and suggesting future NASA projects in the water quality area.

The Committee recommended at the meeting that a questionnaire be mailed to each member to obtain the desired information on key water quality parameters and instrumentation. An extensive questionnaire requesting much detailed information was sent to the members of the Committee approximately two weeks after the meeting. Several questions were designed to obtain information on need, potential applications, and potential demand for the improved coliform detector. The need was well defined; thousands of coliform determinations are performed daily in water, wastewater, public health, and independent labs across the country. Preliminary indications are that immediate applications for the coliform detector will be strictly laboratory-oriented. Once the coliform detector is developed, it should find a readily acceptable market, since it represents a marked improvement over current methodologies with respect to accuracy and time savings.

At present, three laboratory "breadboard" units have been constructed at the NASA Langley Research Center and are being extensively tested in-house. It is expected that a final prototype design will be available by the Fall of 1974.

Future plans for the development of a well-defined instrument capable of monitoring coliform organisms for improved water quality include the selection of a qualified vendor and construction of prototypes, conducting extensive field testing of a number of prototype units and all subsequent tasks necessary for commercialization of the instrument.

*This laboratory model of the NASA coliform detector substantially reduces the time required to quantitatively determine the presence of coliform organisms in water.*



# APPENDIX

## List of Members of PTI's User Requirements Committees

### FIREFIGHTER'S BREATHING SYSTEM USER REQUIREMENTS COMMITTEE

David Gratz, Chief
Montgomery County Fire Department
Silver Spring, Maryland

Robert Hart, Chief
Chicago Fire Department
Chicago, Illinois

Floyd D. Higgins, Chief
Orange Fire Department
Orange, California

Dean Hunter
Assistant Chief Administrative Officer
New Orleans, Louisiana

William Ingram, Battalion Chief
Los Angeles Fire Department
Los Angeles, California

Dodd J. Miller, Chief
Dallas Fire Department
Dallas, Texas

John O'Hagan, Chief
Fire Department of the City of New York
New York, New York

Bruce Reiss
City Manager
Fresno, California

Ross Ritto
Personnel Director
Rochester, New York

Cliff Sligar, Chief
Wheeling Fire Department
Wheeling, West Virginia

Michael Smith
International Association of Fire Fighters
Washington, D.C.

Leo Stapleton, Chief
Boston Fire Department
Boston, Massachusetts

Dean Vanderbilt
Assistant to the City Manager
Dallas, Texas

E. F. Wrought, Chief
Fresno Fire Department
Fresno, California

### FIREFIGHTER'S SHORT-RANGE COMMUNICATIONS EQUIPMENT USER REQUIREMENTS COMMITTEE

George Alexander, Chief
Fairfax County Fire Department
Fairfax, Virginia

Warren Browning
City Manager
Brownsville, Texas

Robert Chase
Budget Director
Los Angeles, California

Robert Deutsch, First Deputy Chief
Baldwin Fire Department
Baldwin, New York

John J. Fogarty, Chief
Division of Fire Control
New York City Fire Department
New York, New York

Edgar P. Grim, Chief
Communications and
Special Services Division
Department of Public Property
Philadelphia, Pennsylvania

Vincent Grote
Communications Superintendent
Division of Communications
Cincinnati, Ohio

Alfred J. Mello
Director of Communications
Police and Fire Department Headquarters
Providence, Rhode Island

William J. Patterson, Battalion Chief
Long Beach Fire Department
Long Beach, California

Edward Smith
City Manager
Hamilton, Ohio

Cliff Wilford
Communications Supervisor
Houston Fire Department
Houston, Texas

## WATER-WASTEWATER MANAGEMENT USER REQUIREMENTS COMMITTEE

Frank Faison
City Manager
Pensacola, Florida

Henry Graeser, Director
Dallas Water Utilities
Dallas, Texas

Arnold Greenberg, Chief
Bioenvironmental Laboratory Section
Berkeley, California

Carmen Guarino
Commissioner and Chief Engineer
Philadelphia Water Department
Philadelphia, Pennsylvania

G. Chris Hartung
Assistant City Manager
Garland, Texas

K. Daniel Linstedt*
Department of Civil and Environmental Engineering
University of Colorado
Boulder, Colorado

Phillip Lynn
Director of Wastewater Control
Knoxville, Tennessee

Wesley McClure
City Manager
San Leandro, California

Robert P. Miele
County Sanitation Districts of Los Angeles County
Whittier, California

Kenneth Miller
Assistant to the Manager for Environment and Quality Control
Denver Board of Water Commissioners
Denver, Colorado

Michael J. Taras*
American Water Works Association
Denver, Colorado

Harold Wolf*
Dallas Water Utilities Department
Dallas, Texas

Darwin Wright, Division Chief*
Office of Research and Development
Environmental Protection Agency
Washington, D.C.

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